

# **NASA Advisory Council**

**May 5 – 6, 2011**

## **Exploration Committee Report**

**Meeting Held: April 26, 2011**

---

**Dick Kohrs**

# Exploration Committee Members

---

- Mr. Bohdan Bejmuk, *Co-Chair*
- Ms. Nancy Ann Budden
- Mr. Joseph Cuzzupoli
- Ms. Carolyn Griner
- Mr. Richard Kohrs, *Chair*
- Dr. John M. Logsdon
- Dr. David Longnecker
- Gen. Lester Lyles
- Mr. Richard Malow
- Dr. Bette Siegel, *Executive Secretary*
- Ms. Shawanda Robinson, *Administrative Officer*

# Agenda

---

Fact Finding Meeting April 26<sup>th</sup> am

Open Meeting April 26<sup>th</sup> pm

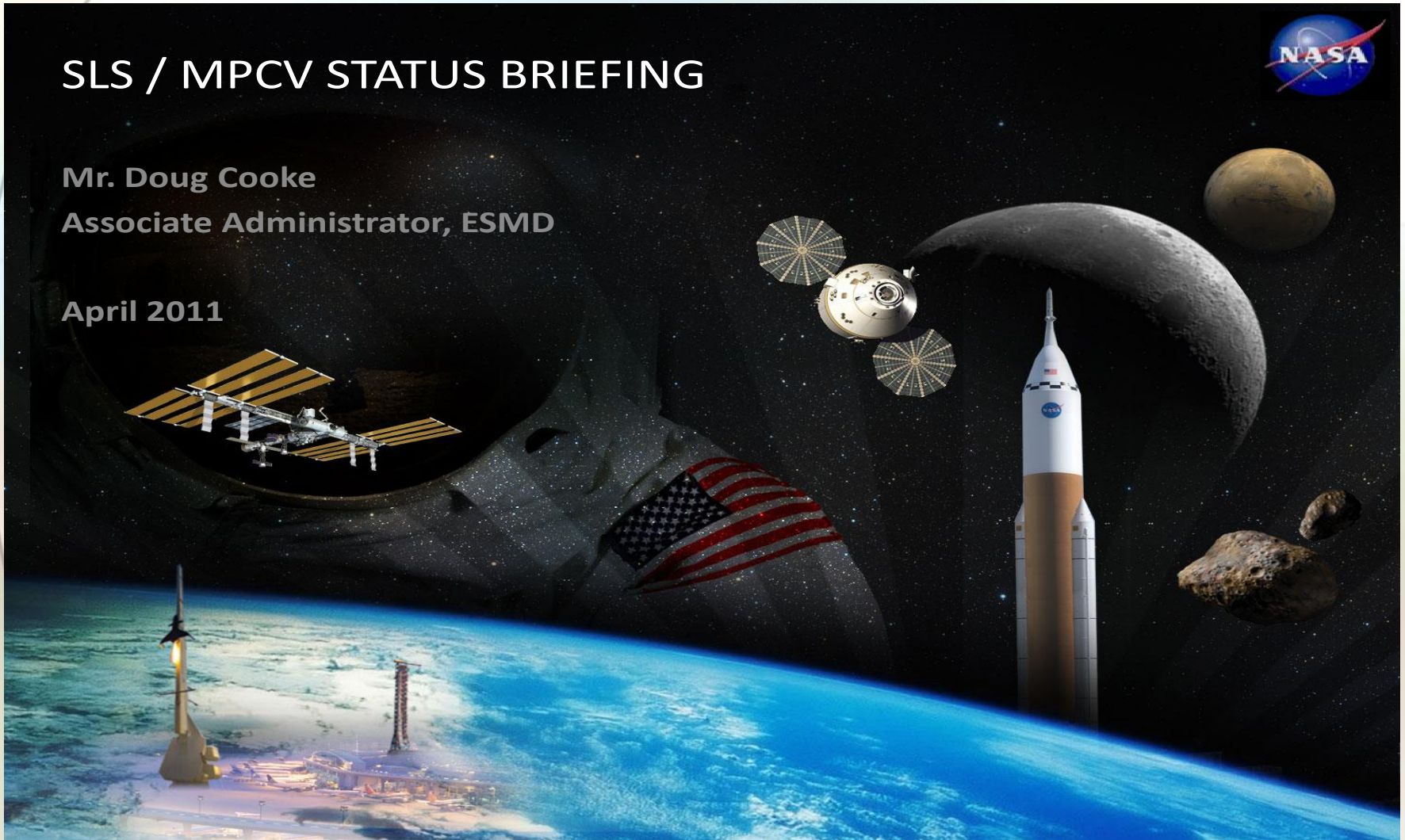
- Update on the Exploration Program –  
*Mr. Doug Cooke*
- Recapturing a Future for Space Exploration: Life and Physical Sciences Research for a New Era –  
*Dr. Elizabeth R. Cantwell*
- Global Exploration Roadmap –  
*Ms. Kathy Laurini*
- Commercial Program Status –  
*Mr. Doug Cooke*

# SLS/MPCV Status Briefing

## SLS / MPCV STATUS BRIEFING

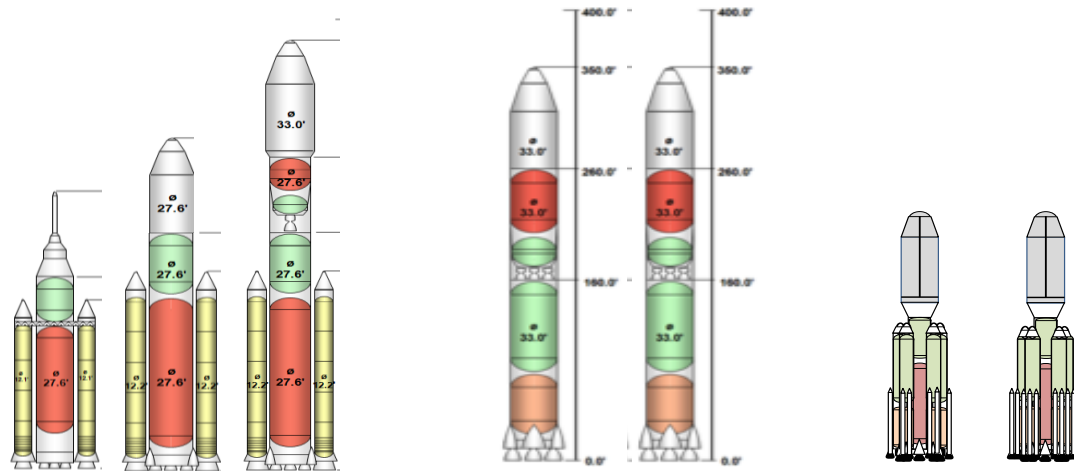
Mr. Doug Cooke  
Associate Administrator, ESMD

April 2011



# Current SLS Concepts

## Current SLS Concepts



	LOX/H <sub>2</sub> – Reference Vehicle Design	LOX/RP	Modular
<b>Description</b>	Hydrogen core configuration with solid strap-on boosters; multiple evolution paths	Large RP configuration (large diameter tanks) with multiple engine options, incl. NASA/USAF common engine	Modular RP configuration (smaller diameter tanks) with multiple engine options, incl. NASA/USAF common engine
<b>Lift Capability</b>	70 mT – 150 mT	100 mT – 172 mT	70 mT – 130 mT

**Note:** Images based on government design solutions from RAC teams

# Highlights From Fact-Finding Meeting

---

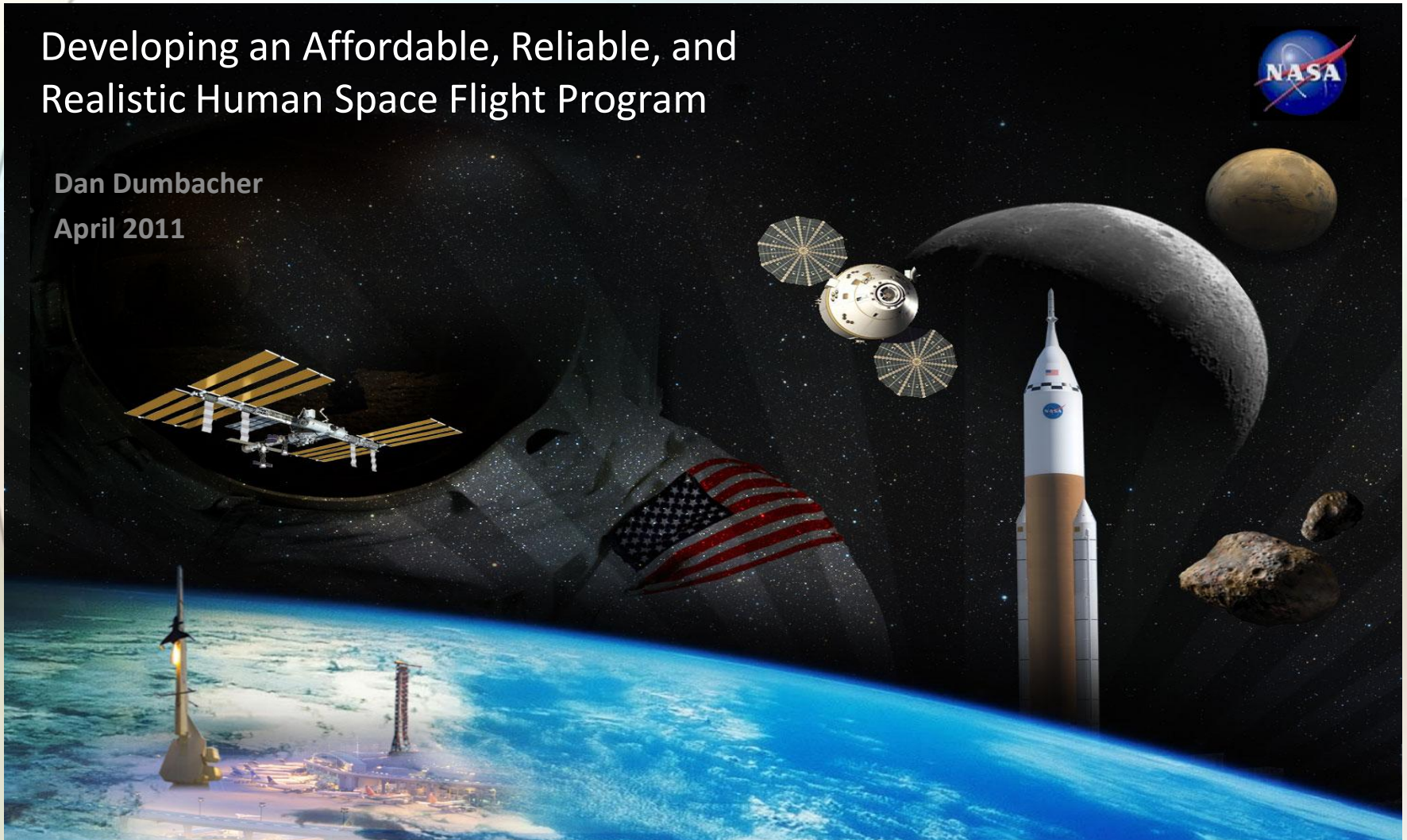
- ESMD and SOMD merging into one organization
- Constellation Program wrapping up
- Creation of Exploration Systems Development (ESD) Division

# Developing an Affordable, Reliable, and Realistic Human Space Flight Program

## Developing an Affordable, Reliable, and Realistic Human Space Flight Program

Dan Dumbacher

April 2011



# MPCV Overview

## Multi-Purpose Crew Vehicle Overview

National Aeronautics and Space Administration

### Orion-derived Reference Vehicle Design



- **NASA has selected the beyond-LEO version of the Orion design (“block 2”) as the MPCV Reference Vehicle Design**
  - Spacecraft to serve as the primary crew vehicle for missions beyond LEO
  - Capable of conducting regular in-space operations (rendezvous, docking, extravehicular [EVA]) in conjunction with payloads delivered by SLS for missions beyond LEO
  - Preliminary trace of top-level MPCV requirements suggests that MPCV is within scope of current Orion contract
  - Final decisions on NASA’s plans for the MPCV will be made during the Acquisition Strategy review process in Spring 2011



# Space Launch System Overview

## Space Launch System Overview

National Aeronautics and Space Administration

### Ares/Shuttle-derived Reference Vehicle Design



- **NASA has selected a Reference Vehicle Design that aligns with the NASA Authorization Act as a starting point for assessment of an affordable, sustainable, and realistic Space Launch System**
  - Heavy Lift Launch Vehicle (HLLV) with an initial lift capability of 70-100mt evolvable to the ultimate capability of 130 mT
  - Reference Vehicle Design is derived from Ares and Shuttle hardware
  - Capability to lift the Multi-Purpose Crew Vehicle
- **SLS Reference Vehicle Design**
  - 27.6' Diameter LOX/LH2 Core Stage
  - Five RS25 based engines using Shuttle assets then RS25E expendable derivative
  - Two 5-Segment Ares derived SRBs
- **Evolving System to 130mT**
  - Add upper stage with one or two J-2X upper stage engines



# Decadal Survey on Biological & Life Sciences In Space

## RECAPTURING A FUTURE FOR SPACE EXPLORATION: LIFE AND PHYSICAL SCIENCES RESEARCH FOR A NEW ERA

WHAT ARE THE KEY SCIENTIFIC CHALLENGES THAT LIFE AND PHYSICAL SCIENCES RESEARCH IN SPACE MUST ADDRESS IN THE NEXT 10 YEARS?



*"In the context of extraordinary advances in the life and physical sciences and with the realization that national policy decisions will continue to shift near-term exploration goals, the committee focused on surveying broadly and intensively the scientific issues necessary to advance knowledge in the next decade. Such a task is never easy; it relies on interpolation and extrapolation from existing knowledge sources and educated assumptions about new developments. The committee grappled with all of these issues as well as the thorny problem of how to organize the scientific efforts themselves procedurally so that they would flourish in the next decade".*

**Betsy Cantwell**

**Wendy Kohrt**

Decadal Survey on Biological and Physical Sciences in Space  
National Academy of Sciences

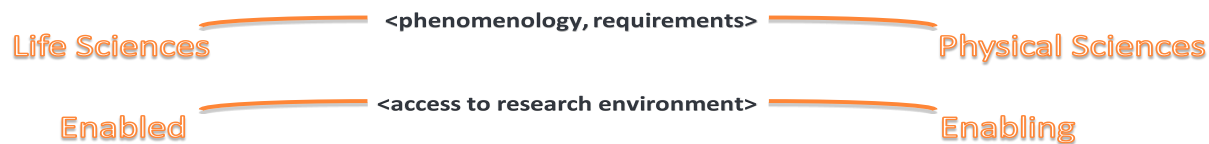
# The Decadal Survey

## THE DECADAL SURVEY

- NASA asked the National Academy of Sciences to:

Define research areas that:

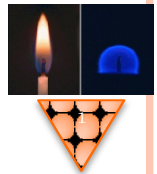
- Enable exploration missions
- Are enabled by exploration missions
- Define and prioritize an integrated life and physical sciences research portfolio and associated objectives;
- Develop a timeline for the next decade for these research objectives and identify dependencies between the objectives;
- Explain how the objectives could enable exploration activities, produce knowledge, or provide benefits to space and other applications;
- Identify terrestrial, airborne, and space-based platforms and facilities that could most effectively achieve the objectives;
- Identify potential research synergies between NASA and other US government agencies, as well as with commercial entities and international partners; and
- Identify potential research objectives beyond 2020.



# The Bottom Line

## THE BOTTOM LINE

*“Although its review has left it deeply concerned about the current state of NASA’s life and physical sciences research, the Committee for the Decadal Survey on Biological and Physical Sciences in Space is nevertheless convinced that a focused science and engineering program can achieve successes that will bring the space community, the U.S. public, and policymakers to an understanding that we are ready for the next significant phase of human space exploration. The goal of this report is to lay out steps whereby NASA can reinvigorate its partnership with the life and physical sciences research community and develop a forward-looking portfolio of research that will provide the basis for recapturing the excitement and value of human spaceflight—thereby enabling the U.S. space program to deliver on new exploration initiatives that serve the nation, excite the public, and place the United States again at the forefront of space exploration for the global good.”*



# Global Exploration Roadmap

---



## **The Global Exploration Roadmap**

### **Overview and Development Status**

**NAC Exploration Committee, Public Meeting  
April 26, 2011**

ESMD/Kathy Laurini

---

# Global Exploration Roadmap

## What is The Global Exploration Roadmap?



### ◆ A tool developed by space agencies to facilitate enhanced coordination and cooperation of global human space exploration activities

- Two Major Thrusts – both technical:
  - Collaboratively develop a long range international strategy(s) for human exploration beyond LEO
    - Reflecting and integrating established agency policies and plans
  - Facilitate identification of near term coordination and cooperation opportunities in 5 areas
    - Use of ISS, robotic missions, infrastructure elements, technologies and terrestrial analogs

### ◆ A non-binding product (document) of the International Space Exploration Coordination Group (ISECG)

- Senior Agency Managers (AA level) agreed to begin development in June 2010
  - GER development planning reviewed with senior managers November 2010
- Initial release planned for mid-2011
- 11 space agencies have contributed to its development



# Global Exploration Roadmap

## The Global Exploration Strategy

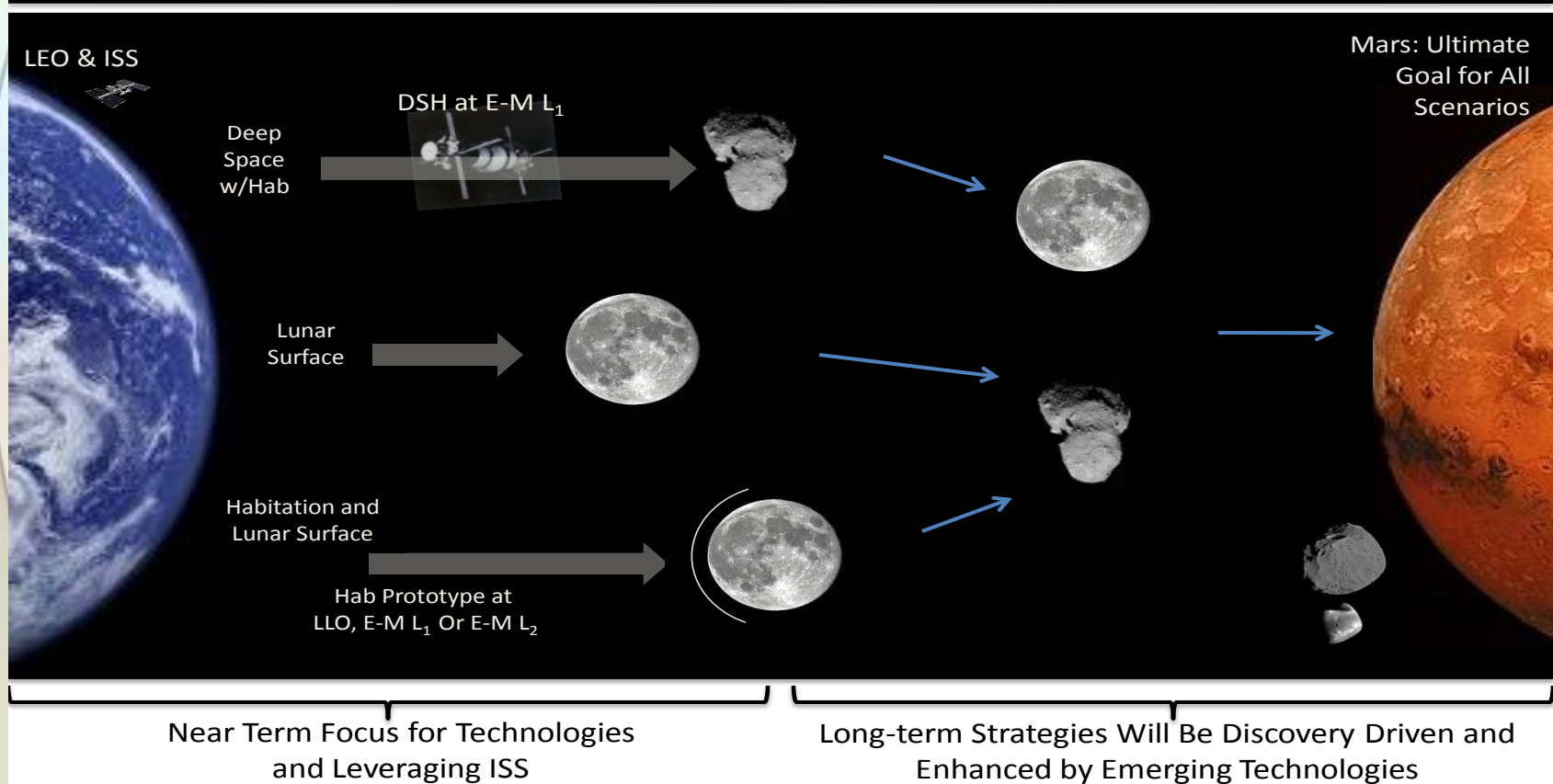


- ◆ ***The Global Exploration Strategy: A Framework for Coordination*** was documented in 2007 by 14 space agencies
- ◆ **Vision** is for a globally coordinated and sustainable human and robotic space exploration effort to destinations that humans will someday live and work
- ◆ **Delivering benefits in 5 thematic areas:**
  - Science and Technology
  - Sustained Presence in the Solar System
  - Economic Expansion
  - Global Partnerships
  - Inspiration and Education
- ◆ **Envisioned a coordination mechanism to promote the vision**
  - International Space Exploration Coordination Group (ISECG)



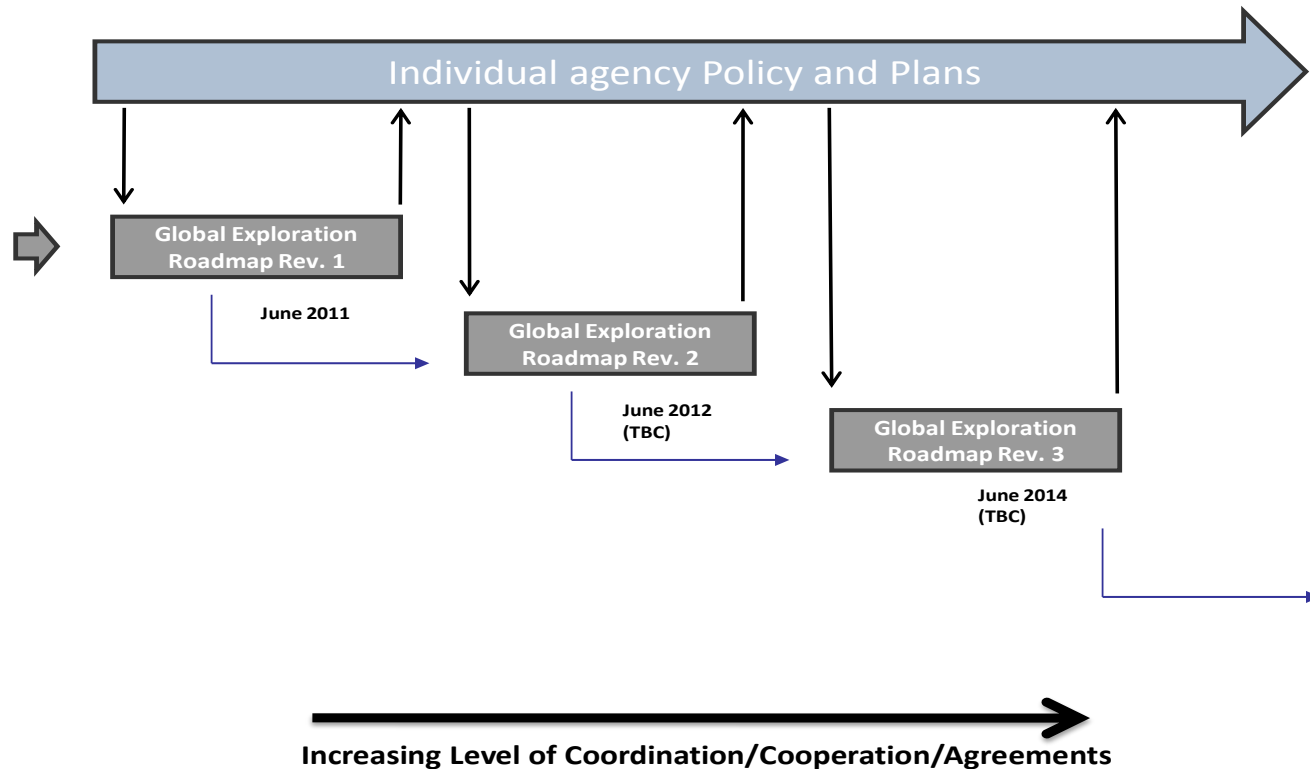
# Global Exploration Roadmap

## Strategies based on Optional Next Steps



# Global Exploration Roadmap

The GER Provides a Technical Basis for Informing Policy and Plans



# Commercial Spaceflight Status

National Aeronautics and Space Administration



## Commercial Spaceflight Status Briefing

**NAC Exploration Committee Meeting**

**April 26, 2011**

**Philip McAlister**



# Commercial Spaceflight Status

## Accomplishments / Milestones


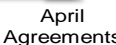


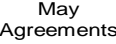





- COTS Cargo
  - 1<sup>st</sup> and 2<sup>nd</sup> quarter augmentation milestones negotiated, signed, and completed by Orbital and SpaceX. 3<sup>rd</sup> and 4<sup>th</sup> quarter milestones in work
  - March 22: Ribbon cutting for Wallops Horizontal Integration Facility
  - March 29: SpaceX Demo 2 and 3 combination briefing to NASA HQ
- CCDev 1 Projects
  - All CCDev 1 Space Act Agreements complete
- CCDev 2 Projects
  - April 18: Awarded four (4) new Space Act Agreements
- Commercial Crew Program
  - March 22: Space Suit Requirement Technical Interchange Meeting
  - April 5: Commercial Crew Program Office officially established at KSC
  - Commercial Crew Program Office will manage the CCDev 2 Projects

# Commercial Spaceflight Status

## Commercial Crew Structure and Timelines



Title	Purpose	CY 2010	CY 2011	CY 2012
<b>CCDev</b>	<b>Develop and demonstrate technologies that enable commercial human spaceflight capabilities.</b>	 February Awards	 April Agreements Complete	
<b>CCDev Round 2</b>	<b>Mature the design and development of elements of the system, such as launch vehicles and spacecraft.</b>	 October Announcement for Proposals	 April Awards	 May Agreements Complete
<b>CCDev Round 3</b>	<b>Mature the design for the integrated end-to-end commercial crew systems.</b>	 June Advance Planning Team Established	 September Announcement for Proposals	 May Awards

# Commercial Spaceflight Status

## CCDev 2 Announcement Overview



- The goals of CCDev 2 investments are to:
  - advance orbital commercial crew transportation system (CTS) concepts
  - enable significant progress on maturing the design and development of elements of the system, such as launch vehicles and spacecraft, while ensuring crew and passenger safety,
  - with the overall objective of accelerating the availability of U.S. CTS capabilities.
- New competition open to all U.S. commercial providers.
- Proposals included NASA investment needed and company contribution.
- Awards are for Space Act Agreements, featuring pay-for-performance milestones from April 2011 to May 2012.

# Commercial Spaceflight Status

## Selection Process and Results



- Four companies were selected for award:
  - Blue Origin: \$22M
  - Boeing: \$92.3M
  - Sierra Nevada: \$80M
  - SpaceX: \$75M
- Total = \$269.3M
- Within the selected concepts, there is diversity in spacecraft approaches (two capsules, a lifting body, and a biconic shape spacecraft) and in the launch vehicles they propose to use.
- All proposals showed an understanding of the importance of safety and a commitment to safe spaceflight.
- NASA believes this portfolio of concepts best meet the goals of CCDev 2 within the available funding. It will significantly mature the design and development of system elements and accelerate the availability of commercial crew transportation system capabilities.

## Observation on Feasibility of Developing SLS by 2016

---

- **Observation:** The only feasible way of achieving initial heavy lift launch capability by 2016 is by using the reference design block approach to development of SLS and to initiate procurement actions promptly. Carefully planned evolution from Block 1 to Block 2 and ultimately to 130MT+ Block 3 is required to ensure cost effective transition through these Blocks while minimizing overall cost of SLS Program.

# Recommendation on Feasibility of Developing SLS by 2016

- **Recommendation:** NASA should engage a competent integration contractor immediately in order to define induced environments (Loads, Vibro-acoustics, and Thermal) and Propulsion System parameters (Propellant flow rates, Engine Pressure Requirements, and required ullage pressures) that envelope design conditions for all 3 Blocks. These enveloped design conditions then can be used to size flight hardware that can be common to all 3 Blocks.
- **Reason:** This approach will minimize expensive redesign and retest requirements as SLS progresses from Block 1, to Block 2, and Block 3.
- **Consequence of no action:** If this recommendation is not followed, there will be deficiency in timely definition of design data for SLS and MPCV, resulting in increased change traffic and increased cost and schedule. Furthermore, if the enveloping of induced environments of all 3 Blocks is not accomplished very early in the design phase of Block 1, unnecessary and costly design changes and associated testing will be required as NASA transitions to Block 2 and 3.

# Recommendation on Heavy Lift Capability

- **Recommendation:** NASA should promptly start development of a new expendable main engine by a US contractor that will provide sufficient power to support a 130 MT or a greater launch vehicle capability. This new engine must support a launch vehicle schedule consistent with the need of the 130 MT launch vehicle schedule.
- **Reason:** For the past 40 years NASA has relied on the Space Shuttle Main Engines (SSME). Russia and other countries have developed main engines for their programs. New technologies and personnel resources as well as higher thrust main engine requirements are needed
- **Consequence of no action:** The US could potentially lose its leadership in Space Exploration.

## Recommendation on Industrial Base

---

- **Recommendation:** The Committee strongly urges that NASA work expeditiously and visibly to ensure that the industrial base supporting engine production and development is sustained and enhanced.
- **Reason:** Financial support of this activity has become time critical—especially given the cancellation of the Constellation program and the end of the shuttle era.
- **Consequence of no action:** Without NASA's attention to this matter, the engine workforce and knowledge base could slowly decline to a point of being unable to develop new leading edge U.S. engine technology

# Observations on Decadal Survey Biological and Physical Sciences in Space

---

- **Observations:** The Committee received a briefing on the Decadal Survey on Biological and Physical Sciences presented by Elizabeth (Betsy) R. Cantwell of the Lawrence Livermore National Laboratory and Wendy M. Kohrt of the University of Colorado. The Committee was impressed by the scope, depth and value of this extensive and detailed analysis of the state of the biological and physical sciences in space, and within NASA in particular.

## Observations on Decadal Survey Biological and Physical Sciences in Space, cont.

---

- **Observation continued:** The Committee noted especially the value of table 13.2 in the study, which identified recommended research priorities for the physical and life sciences for each of eight strategic priorities that might form the basis for additional research in these areas. In essence, this matrix provides a “road map” for research that is guided by strategy, a particularly helpful approach that could inform both broad policy decisions and specific action agendas for funding agencies, NASA and related governmental agencies.

## Observations on Decadal Survey Biological and Physical Sciences in Space, cont.

---

- **Observation continued:** The Committee also noted that radiation did not receive a prominence in the report because the study specifically pointed out that radiation had received detailed attention in separate reports prepared by the National Academies. Further, it noted that the study charter specifically excluded detailed budget planning from the purview of this study group.

# Recommendation on the Decadal Survey on Biological and Physical Sciences in Space

- **Recommendation:** NASA should appoint an Associate Administrator for the Life and Physical Sciences, charged with appropriate responsibilities and authority to ensure that integrated, coordinated and sufficient approaches to these areas are achieved in order to support the needs for future human space exploration, and to foster science developments that further the nation's role as a leader in space-related science.
- **Reason:** The budgetary consequences of the ESAS process had major negative consequences on the physical and life sciences, both within NASA and in the external research community, yet advances in these areas are essential for the future of human space exploration. The Committee endorses the content of the decadal report and wishes to specifically endorse the need for an integrated approach to research in the life and physical sciences within NASA, one that is supported by stable and sufficient funding that fosters advances not only within the agency but also within the external research community. In order to foster the necessary integration and emphasis within NASA, the Committee believes that a senior level administrator (i.e., AA) is needed to manage and represent the life and physical sciences initiatives within NASA.
- **Consequences of no action:** We will not have an integrated, coordinated approach to support human space exploration. In addition, we will not maintain the nation's role as a leader in space related science.

## Finding on the Global Exploration Roadmap

---

- **Finding:** NASA's budget doesn't support the Capabilities Architecture as currently defined without International and Inter-agency engagement. The initiative on the Global Exploration Roadmap is a good platform for these discussions. We encourage them to continue these discussions and to begin to be more specific.